



Assessing Hearing Health Hazards of the Multi-role, Anti-armor, Anti-personnel Weapon System (MAAWS)

Nancy L. Vause¹ COL (R), PhD, Kevin J. Finch², Benjamin M. Sheffield¹, John L. Dull Jr.², Devon M. Kulinski^{3,4}, AuD, Robin Zeto⁵

¹Army Hearing Division, U.S. Army Public Health Center, Aberdeen Proving Ground, MD

²PM Soldier Weapons, Picatinny Arsenal, NJ

³Audiology and Speech Pathology Center, Walter Reed National Military Medical Center

⁴Audiology and Speech Pathology Center, Madigan Army Medical Center

⁵Army Test and Evaluation Command, Aberdeen Proving Ground, MD

Joint Defense Veterans Audiology Conference
February 10, 2020



Outline

- Introduction – Dr. Vause
- Overview of Carl Gustaf / Multi-role Anti-Tank Anti-Personnel Weapons Systems (MAAWS) – Ms Robin Zeto
- Public Health Surveillance Project: May 2018 – Present – Dr. Vause
 - JBER, SAAB BOFORS Sweden, Ft Polk, Ft Drum, Camp Shelby
 - Enhanced EarPro Education &/or FitCheck Interventions - Grafenwöhr Germany, Ft Benning, Ft Bragg, Ft Drum
- FitCheck Methodology, Results, and Future Direction – Dr. Kulinski
- Pre/Post Noise Exposure Audiogram Methodology, Results, and Future Direction – Mr. Sheffield
- Opportunities to get involved at your installation
- Q&A





Multi-role, Anti-armor, Anti-personnel Weapon System - MAAWS

M3 Carl Gustaf Recoilless M3 Rifle (84mm) – New Lightweight 7 lbs lighter –
EMR to Conventional Forces



MAAWS munitions

High Explosive (HE) 441D Reduced Sensitivity (RS) cartridge

Target Practice Tracer (TPT) 141 cartridge

High Explosive Dual Purpose (HEDP) 502 RS cartridge

Sub-Caliber Adapter (SCA) 553B





Unclassified

U.S. ARMY ABERDEEN TEST CENTER

Noise Testing for the MAAWS





Soldiers firing HE 441 video



M3 & M3E1 MAAWS Comparison

Rifle Part	M3 Rifle	M3E1 Rifle
Weight	21.4 lbs.	14.6 lbs.
Length	41.9 inches	39.4 inches
Barrel Liner	Steel Liner	Titanium Liner
Venturi	Steel	Titanium with steel ring



M3 MAAWS



M3E1 MAAWS

MAAWS Family of Munitions

USSOCOM Fielded Rounds

U.S. Army Rounds



HEDP 502 RS



HE 441D RS



HEAT 551C RS



ASM 509



MT 756



ADM 401/401B



TPT 141



Subcaliber Adapter
(SCA) 553B fired w/
7.62mm & Backblast



TP 552



ILLUM 545C

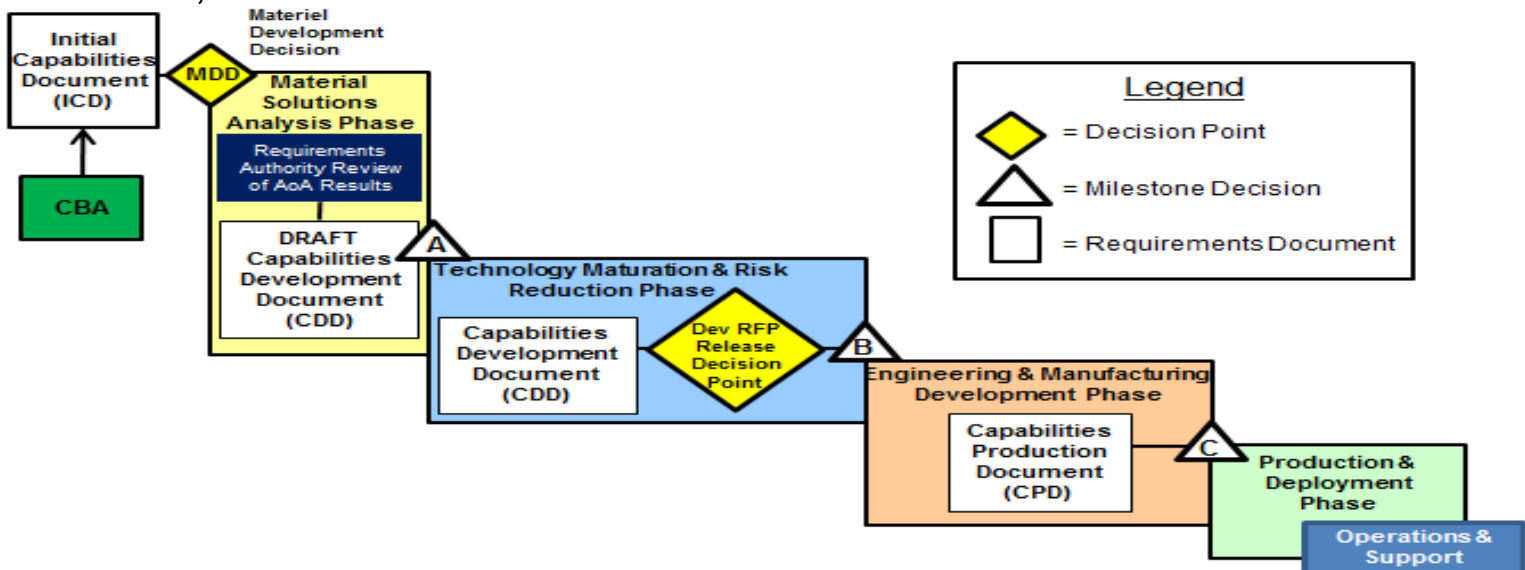


SMOKE 469B

Testing Process

■ Regulations

- Initial Capabilities Document (ICD)/ Capabilities Development Document (CDD)/ Capability Production Documents (CPD)
- MIL-STD-1474D and E, Department of Defense Criteria Standard for Noise Limits for Army Materiel
- Army Regulation 40-10, Health Hazard Assessment Program in Support of the Army Material Acquisition Decision Process
- ITOP 4-2-822, Electronic Measurement of Airblast Overpressure and Impulse Noise
- TOP 4-2-831, Use of Blast Test Device (BTD) During Auditory Blast Overpressure Measurements
- TOP 1-2-608, Sound Level Measurement



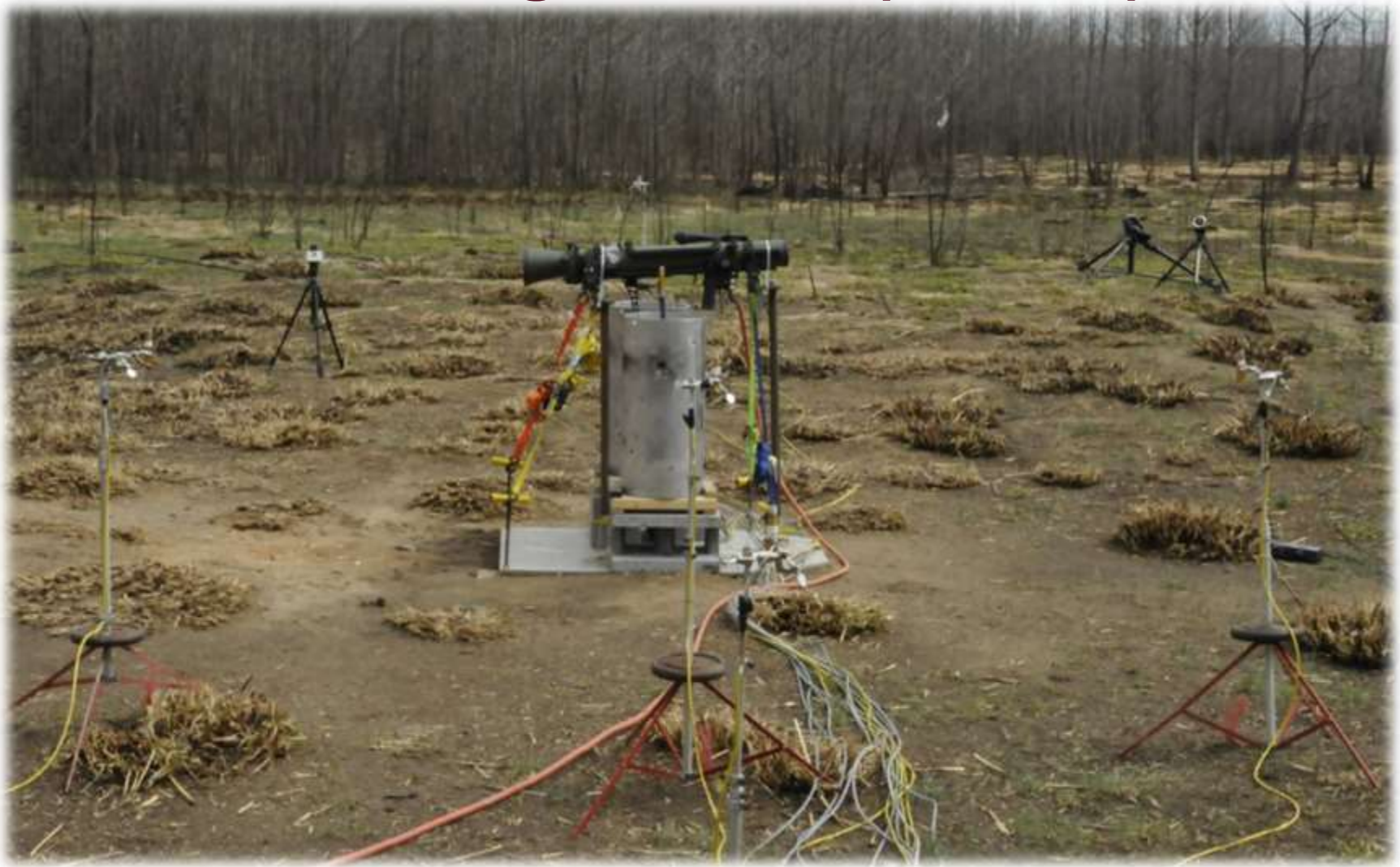
Noise PCB Gauge Location



Noise and Blast Overpressure Standing Position (160 cm)



Noise and Blast Overpressure Kneeling Position (103 cm)



Noise and Blast Overpressure Sitting Position (76 cm)



Noise and Blast Overpressure Prone Position (30 cm)



Video of MAAWS M3E1 firing the ASM 509 round



JBER, AK
July 2017
MAAWS NET
Public Health Study

Mission: Conduct pre/post exposure DOEHRS-HC audios, observe and document earpro use, fit and wear, document # of Rounds fired and firing postures, record weather conditions.

- Subjects 17 Soldier Subjects (4/25 INF) 3 Instructors (PM MAAWS)
- Earpro Soldier Fit, Inserted and Worn – Unit provided foam Sound Guard + Peltor Muffs. Observed and documented fit pre/post.
- Hearing (EarPro) Education MAAWS NET instructors classroom only – none on the range – passed out foam earpro
- Audios PRE–Conducted pre exposure same day
POST–Conducted w/in 1 hr of exposure
RETEST – 14 Hrs noise free
- Weather Monitored and recorded temp/humidity/wind
- Simultaneous WRAIR TBI sensor study



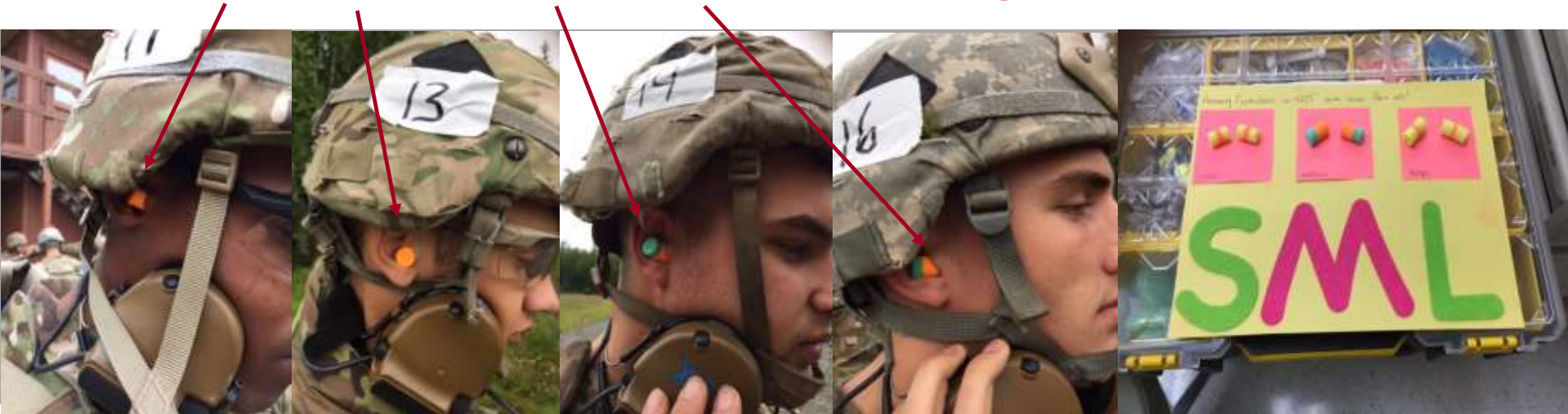


Joint Base Elmendorf Richardson, AK July 2017



Improper earpro fit and wear

Sizing available at AHP center





Joint Base Elmendorf Richardson, AK July 2017

- Hearing Injury Criteria +/- 10, Any Hz, Either Ear
- Results 18% Temporary – 1 hr Post Exposure (30% FT Bragg 93)
12% Permanent - 14 Hrs Noise Free (17% FT Bragg '93)
HHA predicts 95% population protection w/double earpro
(only 5% could/should/would experience 25 dB NIHL)
- Observation: All reported NO individual earpro check
All required SM or LG Foam but were fit w/Med earpro
Soldiers did not know how to insert foam earpro
Soldiers w/Hearing Injuries were sized improperly
- Recommendation: Design and implement pilot test of FitCheck intervention -
SAAB BOFORS new M3E1 lightweight MAAWS ATC
field testing Sept 2017



Bottom line - BGO

NO
SOLDIERS DON'T
KNOW

WHAT RIGHT EARPRO

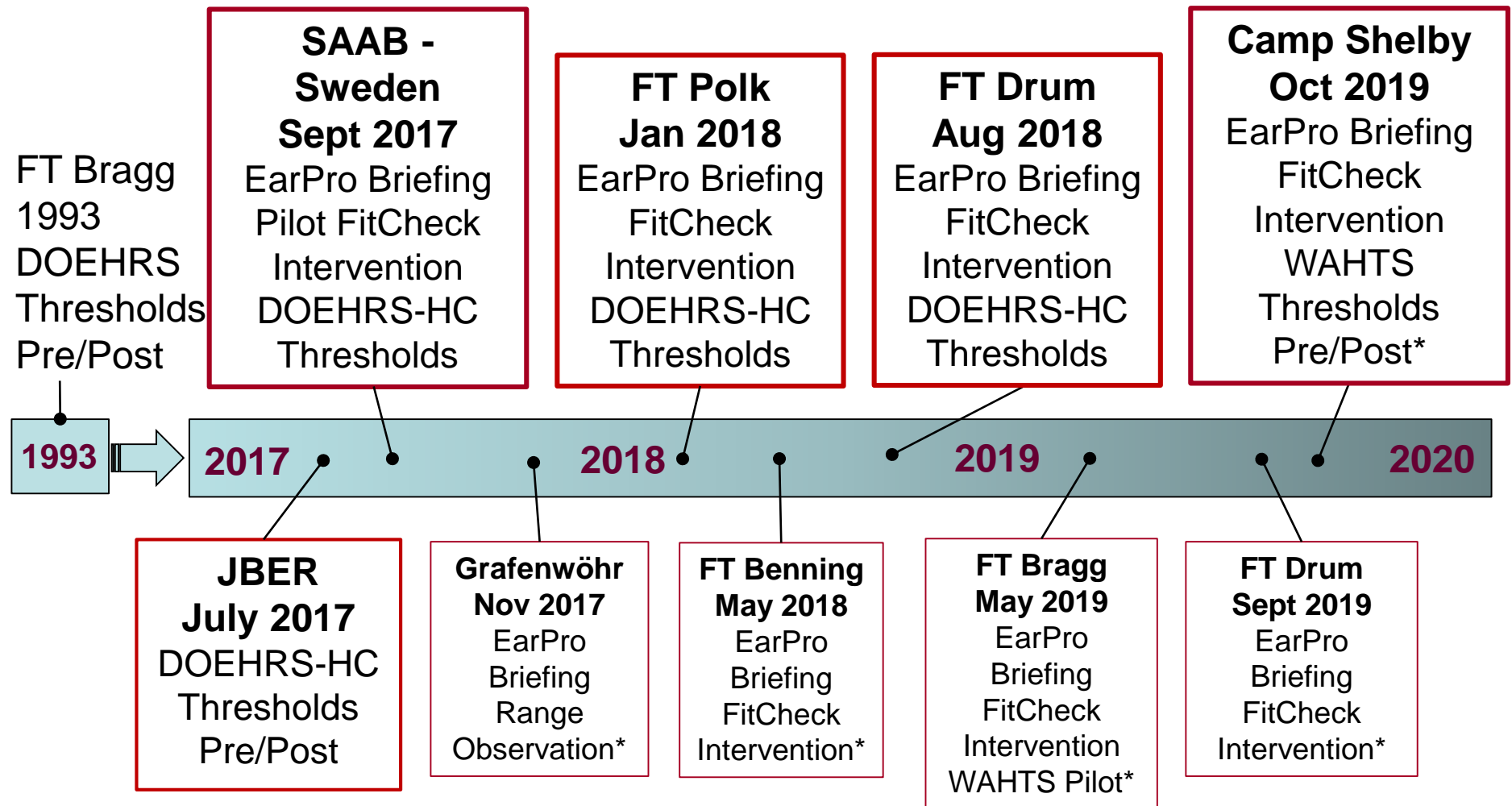
FIT FEELS LIKE

(even after Targeted EarPro Briefing)





TIMELINE



* MAAWS NET events NOT included in study (No pre/post exposure thresholds)

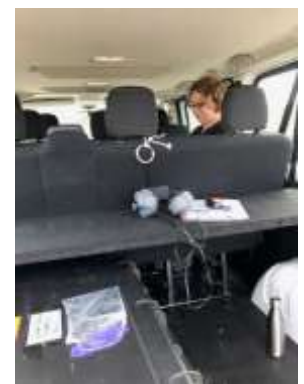
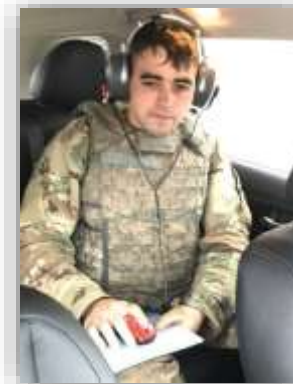




FitCheck Solo

FitCheck Intervention following “Targeted Earpro Briefing”

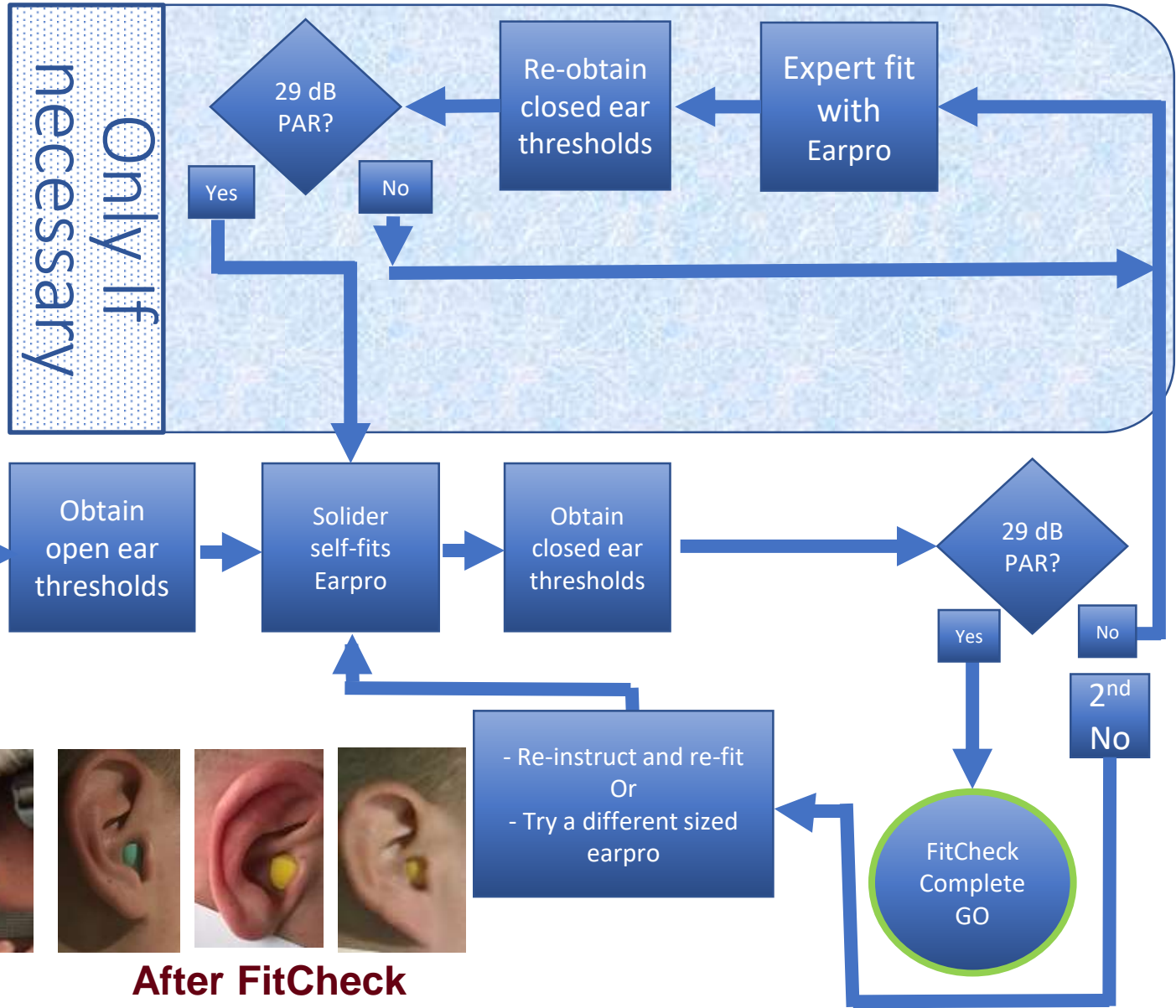
- To mitigate the intensity of this weapon, each Soldier completed a specialized computer assessment (FitCheck) to objectively quantify the amount of personal protection received from deep-fit foam earpro (earplugs)
- Soldiers had to self-fit and achieve ≥ 29 dB **Personal Attenuation Rating (PAR)** to receive a **Go and FIRE!**
- Soldiers wore a second layer of earpro (Peltor noise muffs) for double protection to achieve the required 34 dB PAR.



FitCheck Methodology:

BEFORE
Firing
MAAWS
Soldiers
needed

Earpro
Assessment
with
FitCheck
Solo

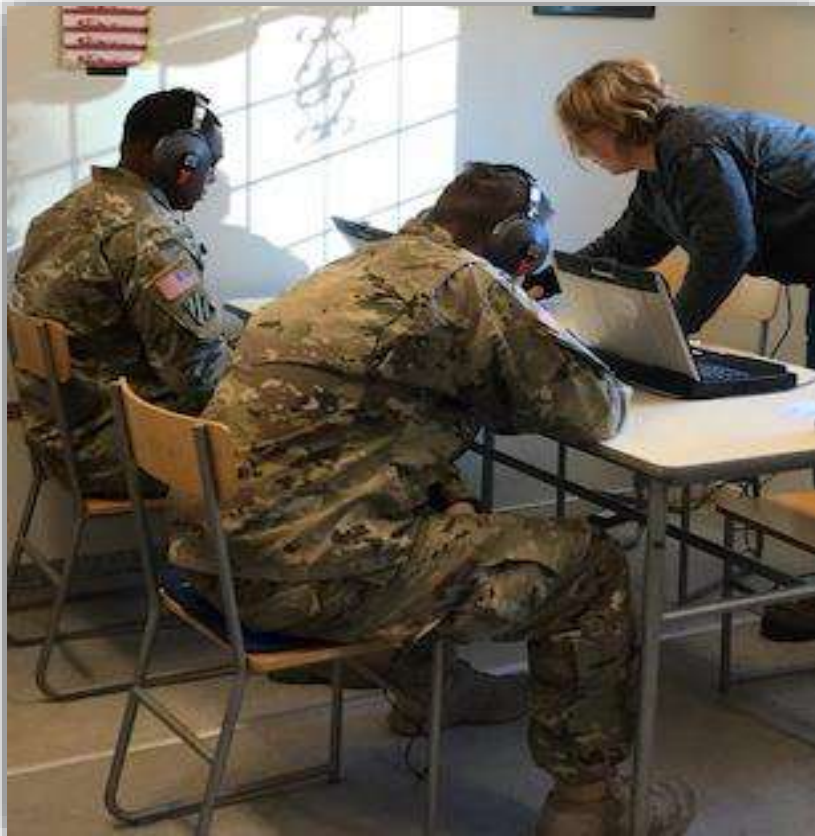


Before FitCheck
Testing

After FitCheck
Testing



Garrison Initial vs Field Testing



JRTC, FT Drum, Camp Shelby MAAWS NET Public Health Study

Mission: Determine if intervention measures coupled w/HHA (e.g., firing restrictions, “targeted” earpro education, individual fitting & FitCheck 29 dB PAR) are sufficient to prevent MAAWS (legacy & M3E1) NIHL. Conduct pre/post exposure DOEHS-HC – WAHTS audios, document earpro use, fit and wear, conduct pre/post FitCheck PARs, # of Rounds fired and firing postures, record weather conditions.

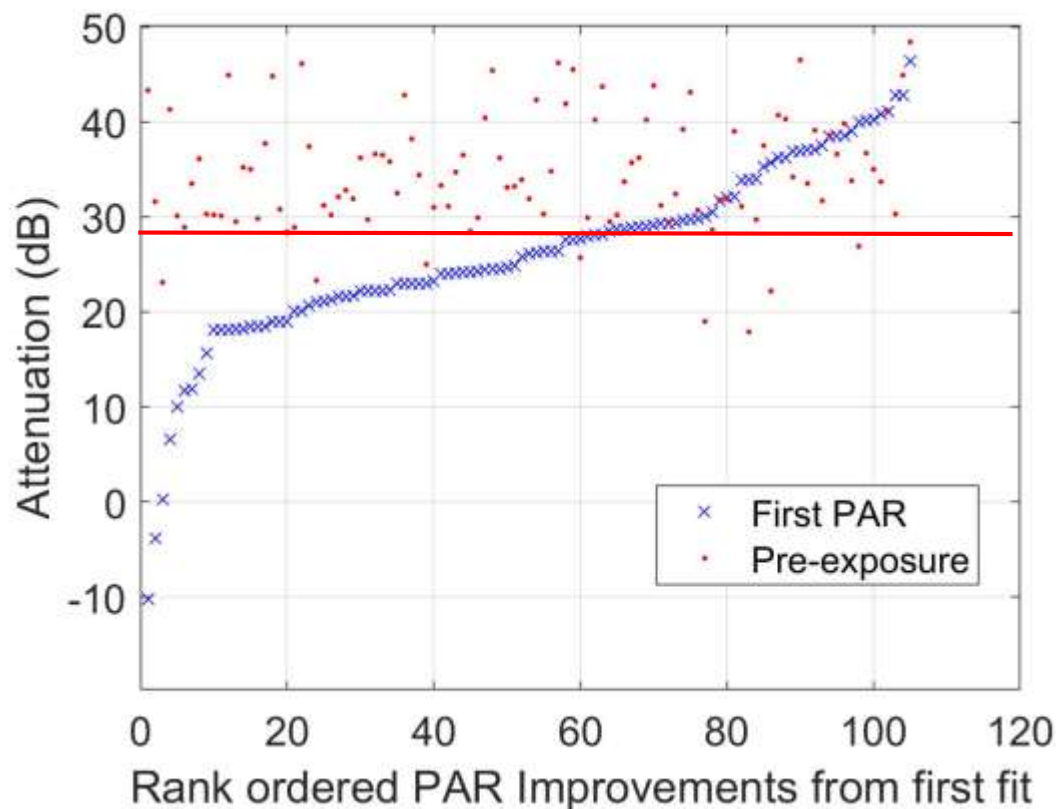


FitCheck training enabled Soldiers to KNOW what right earpro fit feels like





1st PAR vs 1st Pre Exposure PAR



29 dB PAR on 1st try = 36%
29 dB PAR 1st try on the Range
pre-exposure = 88%

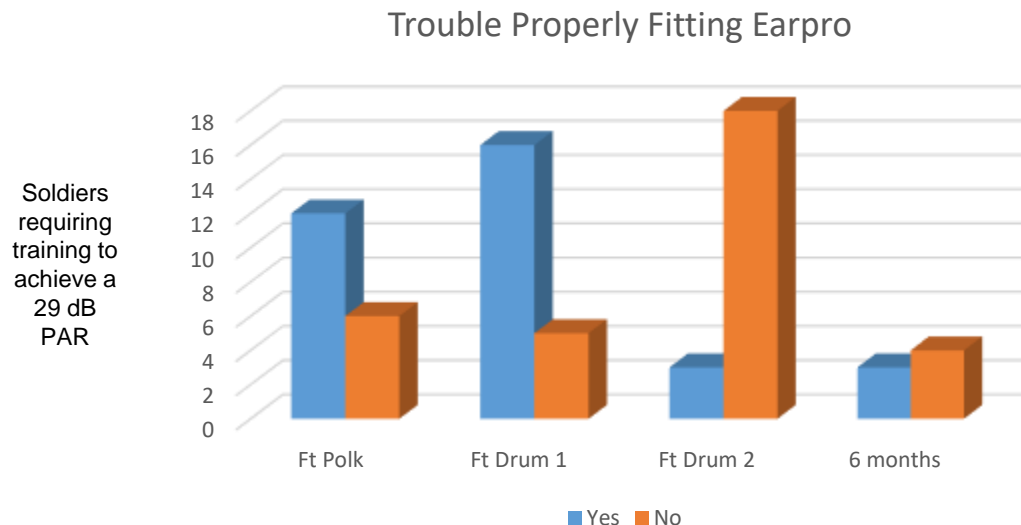
Soldiers who did NOT achieve
a 29 dB PAR on 1st try were
re instructed and/or refit and
retested until they achieved the
required 29 dB PAR for a GO
PRIOR to firing!

t Value 5.94 <.0001

2-22 INF Ft Drum, NY Fit Tested at JRTC and Retested at FT Drum

Mission: Determine if earpro fit is a perishable skill.

- Subjects 7 Soldier Subjects (2-22 INF) at JRTC (Jan) and FT Drum (Aug)
- Earpro Compared FitCheck competence after 6 months to determine if proper earpro fit a perishable skill requiring retraining.
- After 6 months 4 of the 7 Soldiers could obtain 29 dB PAR on the first try.
- Sample Size too small - NS





Bottom line - BGO

FitCheck

**Trains SOLDIERS to
KNOW**

WHAT RIGHT EARPRO

FIT FEELS LIKE

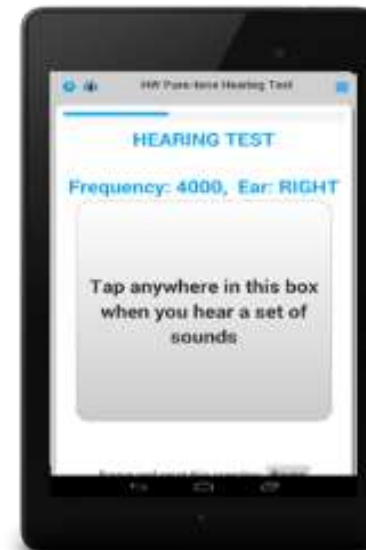




Wireless Automated Hearing Test System WAHTS

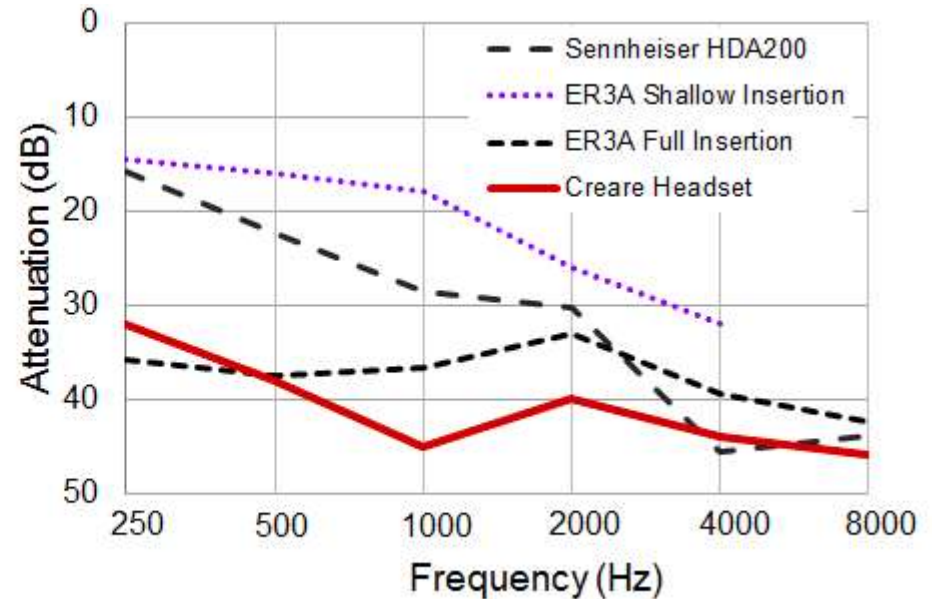


**Battery contained in opposite earcup*





Wireless Automated Hearing Test System



Meinke, D. K., Norris, J. A., Flynn, B. P., and Clavier, O. H. "Going Wireless and Booth-less for Hearing Testing in Industry," *International Journal of Audiology*, Vol. 56, 2017, pp. 41–51.



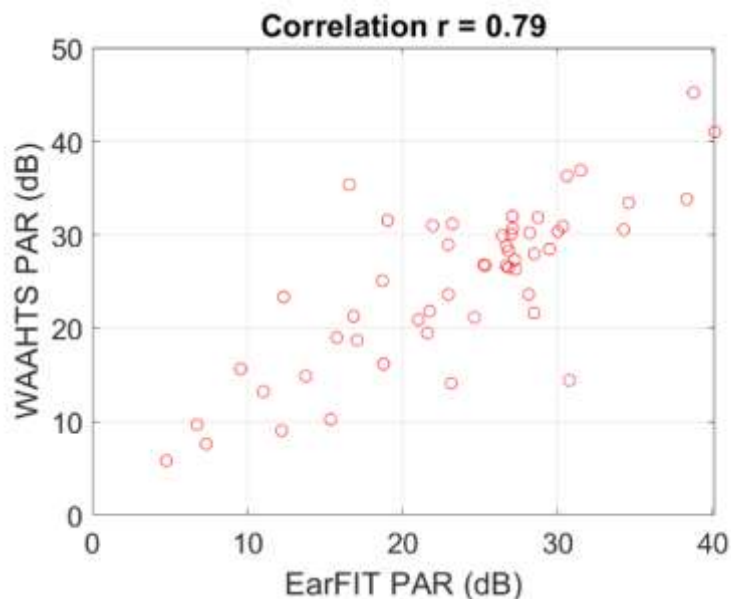
Field Testing Fun – A Hard Day's Night





Field evaluation of hearing threshold & FitCheck using a mobile audiometry system

WAHTS PAR vs 3M EARfit PAR



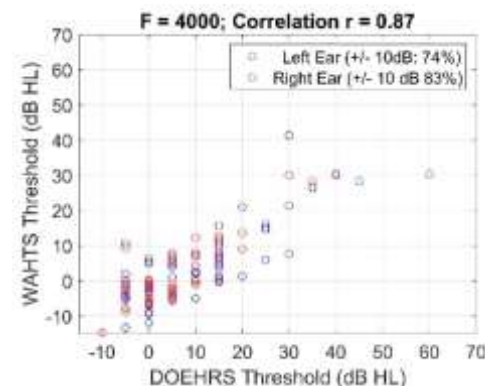
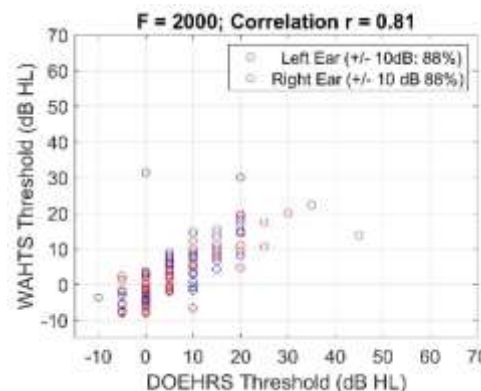
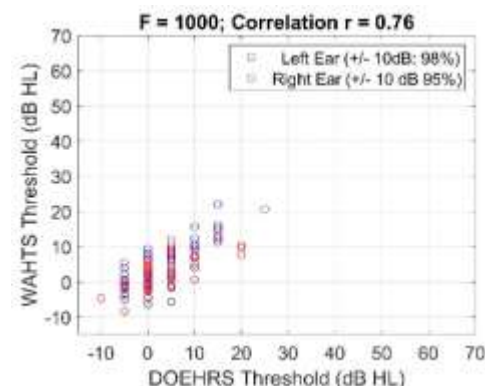
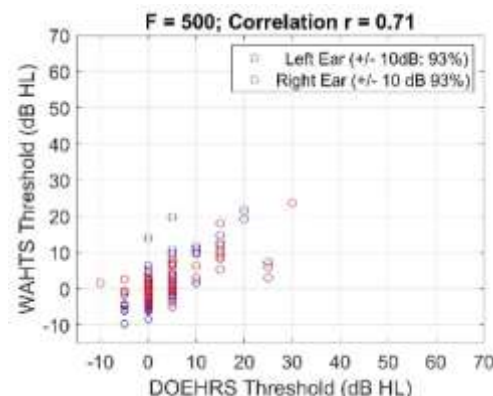
Future Implementation:

- Capable of expanding fit testing in the operational environment
- Able to measure hearing thresholds directly before and after noise exposure

Goal:

Evaluate WAHTS in obtaining threshold information with/without insert HPDs.

WAHTS vs DOEHRs Threshold Comparison





Methods for Collecting Audiograms Pre/Post Noise Exposure

- DOEHRS-HC (Benson CCA-200)
 - multi-station booth (6-8 persons)
 - 500, 1000, 2000, 3000, 4000, 6000 Hz
- PRE – Conduct same day as range at AHP clinic
- POST – Conduct w/in 1 hr post exposure at AHP clinic
- RETEST – after 14 hrs noise free for those with +10dB shift at any one frequency in either ear



Methods for Collecting Audiograms Pre/Post Noise Exposure

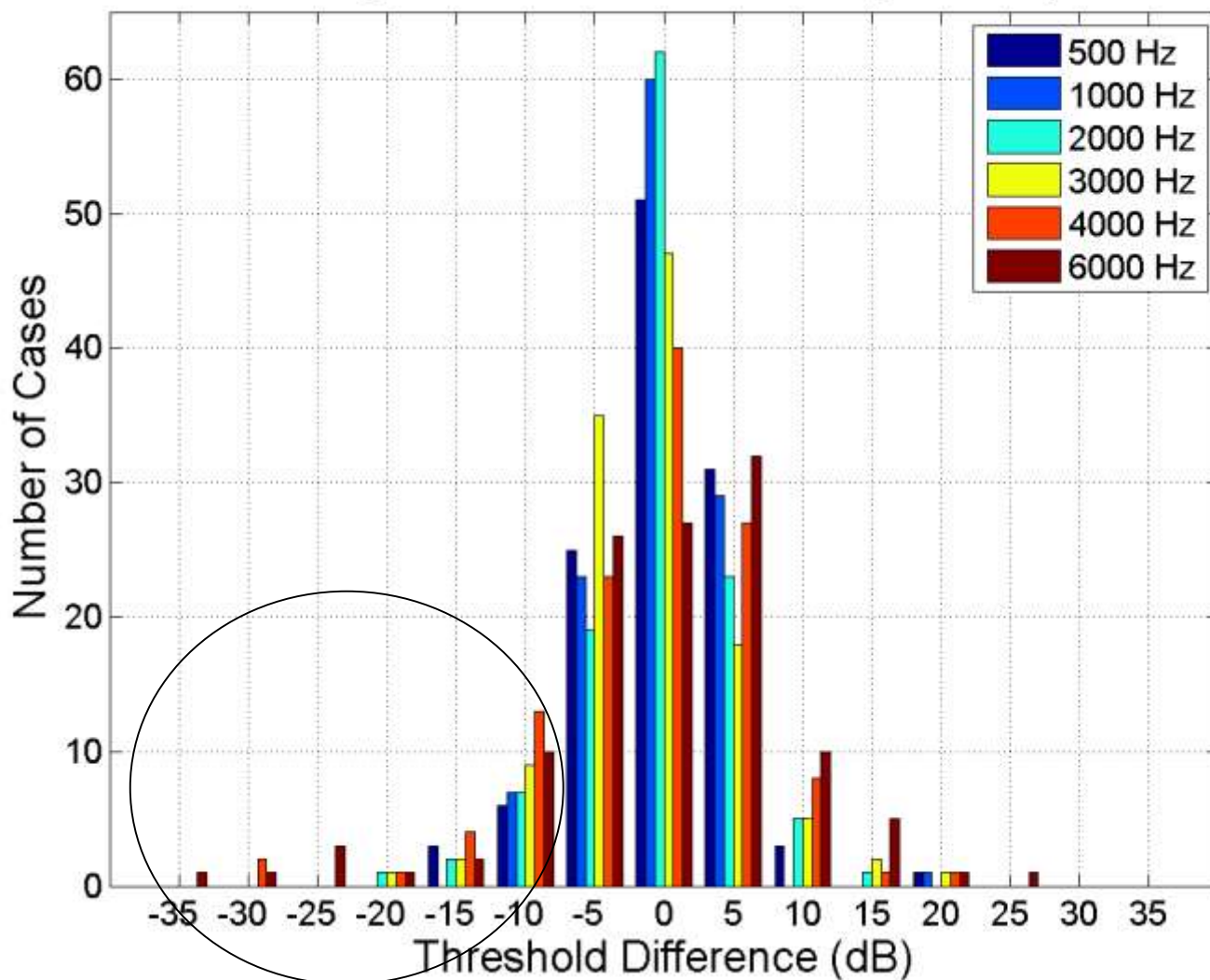
- **Advantages of DOEHRs-HC in clinic**
 - System used for audiogram of record
 - Subject familiarity
 - Double-walled sound booth
- **Disadvantages of using DOEHRs-HC in clinic**
 - Logistically cumbersome
 - Time consuming for the participants
 - Difficult to capture post-noise exposure audiogram in timeframe immediately after exposure (i.e. min 30-60 minutes as opposed to 5-10 minutes)
 - Not engaging for participants, prone to fall asleep during test, especially after long day at the range





DOEHRS-HC Post Exposure Threshold Shifts

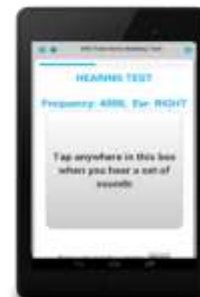
Histogram of all threshold shifts (DOEHRS)



**FT BRAGG
MAAWS NET
Public Health
Intervention**

Mission: APHC study team was not notified to provide sufficient time to gather data for 17-522 public health study. Sent equipment to local 72C to train unit medics to conduct individual fitting & FitCheck 29 dB PARs; document earpro use, fit and wear. Conduct pre/post FitCheck PARs, and targeted earpro training. Conduct WAHTS field testing pilot.

- Subjects 82 ABC Soldiers
- Earpro Trained unit medics to conduct individual earpro sizing & FitCheck Soldiers Fit w/S, M, L Foam
- FitCheck Training Trained unit medics to operate FitCheck Equipment to train Soldier “what right ear pro fit feels like” achieve and confirm a 29 dB PAR.
- Hearing Health Provided “Enhanced” HHE, earpro fit, use and wear
- Audios Conducted WAHTS PRE/POST on range – just 4 and 6 kHz



3rd BCT MAAWS (Carl Gustav) NET



Situation:

PEO Soldier fielded the M3E1 Multi-Role Anti-Armor/Anti-Personnel Weapon System (MAAWS) to four battalions (8-10 teams of two) from 23-April to 03 May 2019. Lighter and shorter than the M3 Legacy 84 mm recoilless rifle, the weapon is reusable and has a range of 700 m//1300 meters (soft). It is the loudest shoulder-fired weapon system, with a peak average of 188 dBP SPL, a full 28 dB above thresholds for tissue damage (i.e., blown eardrums, sheared nerve endings, etc.)

Summary:

To mitigate the intensity of this weapon (which has resulted in hearing injuries sustained during the train-up), a specialized computer assessment, called FitCheck, was completed on each firer to objectively quantify the amount of protection received from deep-fit foam earplugs. Soldiers had to self-fit and achieve **≥29 dB of noise reduction** from foam earplugs alone to receive a **GO**. Peltor noise muffs were then worn overtop for double protection with situational awareness. FitChecks were done by unit medics trained by the XVIII ABN Corps FHP - Hearing Program Officer. During the exercise, pre- and post-hearing tests were quickly conducted using new, "booth-less" technology in FLAs.

Key Take-Aways:

Range hearing tests indicated only one temporary shift in hearing out of 15 firers tested. By coupling weapon training with preventive med support, not only were Soldier lethality AND survivability enhanced, but a new capability for identifying injuries downrange was validated.



FitCheck Testing



Hearing Assessments

**JBER 4/25 BCT
at Camp Shelby, MS
Oct 2019 MAAWS NET
Public Health Study**

Mission: Continue AHD study to determine if Study Team & HHA recommendations (e.g., firing restrictions, targeted earpro education, individual fitting and confirmation with FitCheck technology) are sufficient and effective measures to prevent noise induced hearing loss (NIHL) when firing the M3E1 MAAWS. Conduct pre/post exposure **WAHTS** audios, observe and document earpro use, fit and wear, conduct pre/post FitCheck measurement, document # of Rounds fired and firing postures, record weather conditions.

- **Subjects** 47 Soldier Subjects (4/25 BCT) (2 Range Days)
- **Earpro** Initial Individual sizing & FitChecks: Sound Guard Foam must achieve 29 dB PAR. Conduct FitChecks Pre/Post exposure. (Is proper earpro fit a perishable skill requiring retraining? 3 vs 5 Frequency PARs)
- **Hearing Health** Provide “TARGETED” HHE, earpro sizing fit, use & wear, FitCheck earpro testing: initial, pre/post range exposure
- **Audios** PRACTICE - Conduct WAHTS pre-test in classroom day of range
PRE – Conduct WAHTS pre-test at range immediately prior to firing
POST – Conduct immediately after occluded only FitCheck (within 10 minutes of walking off the range)
Retest – 14 hrs noise free if +10 dB or greater
- **Weather** Monitor and recorded temp/humidity/wind



JBER 4/25 BCT at Camp Shelby, MS Oct 2019

- Hearing Injury Criteria +/- 10, Any Hz, Either Ear
- Results .8% Temporary – >1 hr Post Exposure
 .2% Permanent - 14 Hrs Noise Free

- Observation:

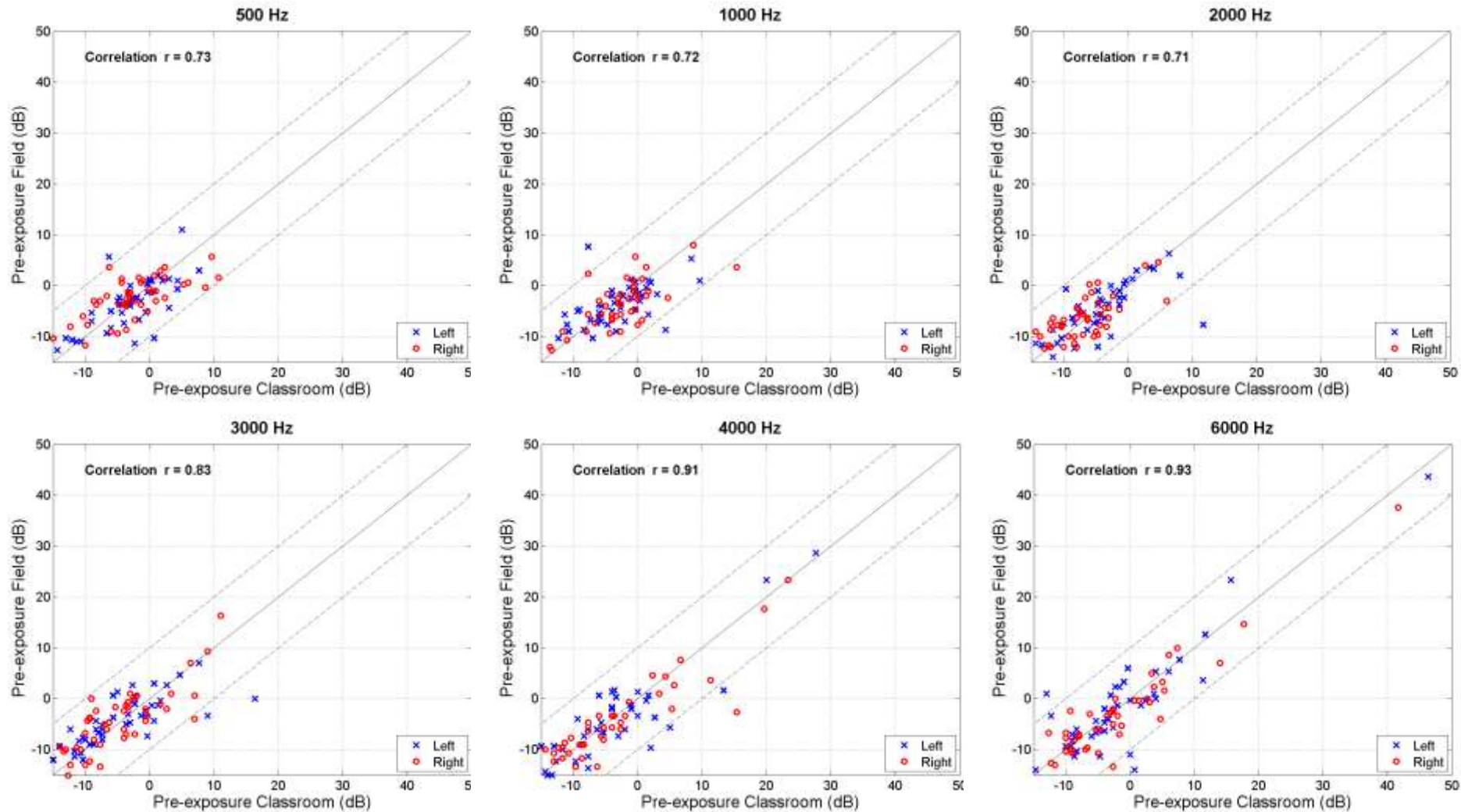


Medics can test 2 Soldiers Simultaneously
Soldiers have improperly sized earpro
FitCheck trains Soldiers “Right Feels Like”
DOEHRS-HC and WAHTS referral differences
DOEHRS-HC +/- 10 appears to be a stringent criterion
but WAHTS referrals are closer to model predictions

- Recommendation: Implement Targeted Earpro briefs & FitCheck Testing
Continue earpro fit skill perishability studies, & equipment
field test/retest variability
Explore WAHTS and DOEHRS-HC field differences
Include WAHTS and FitCheck in 72C SKO

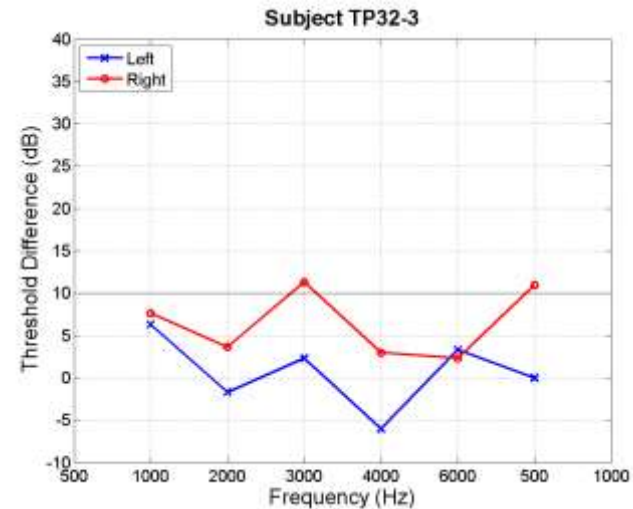
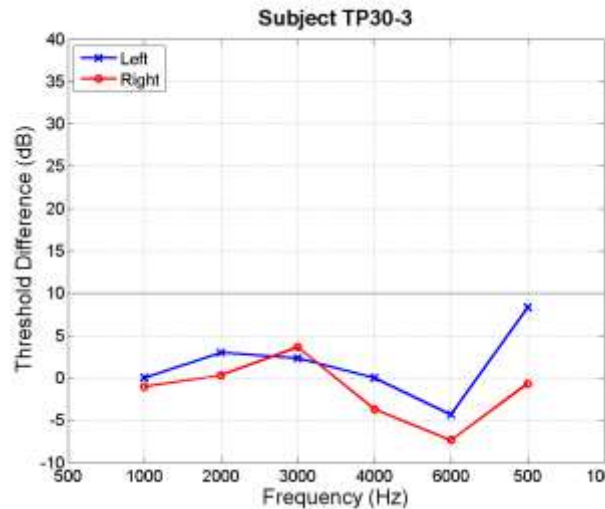
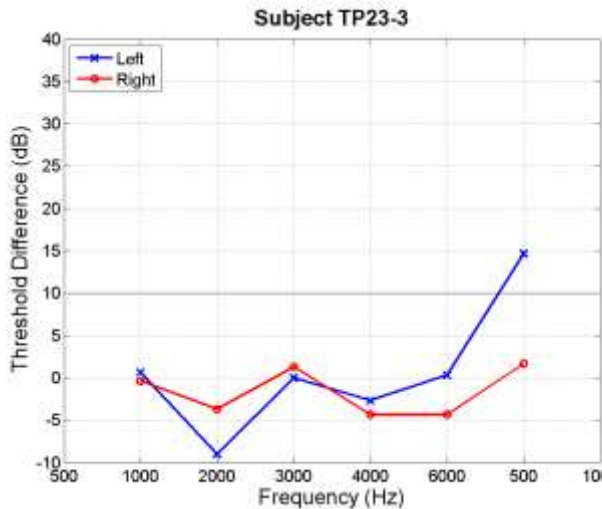
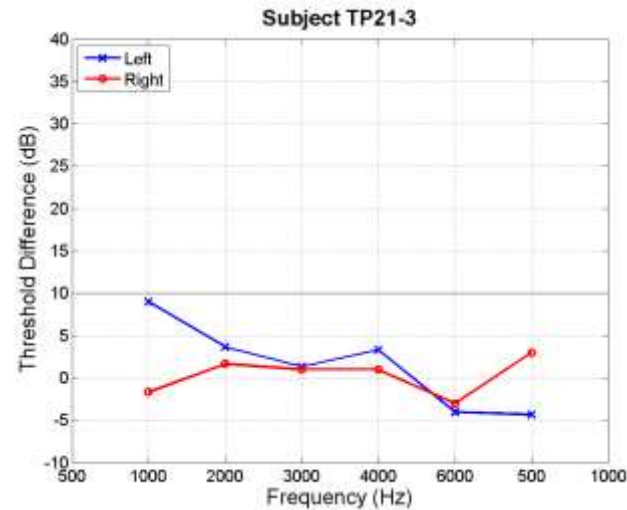
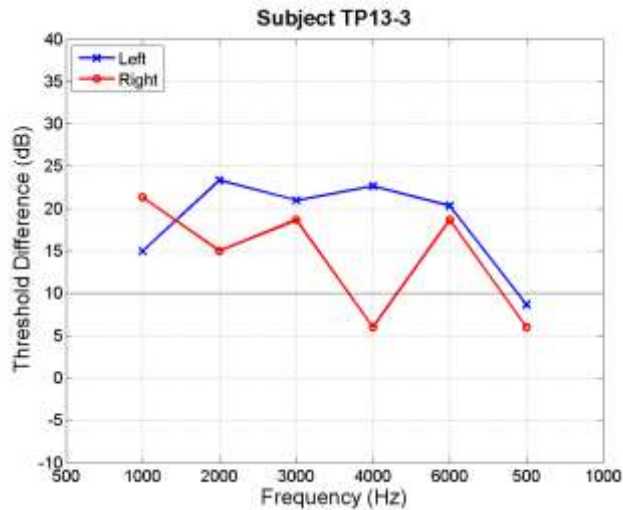


WAHTS Correlations Pre-Noise Exposure Field vs Classroom





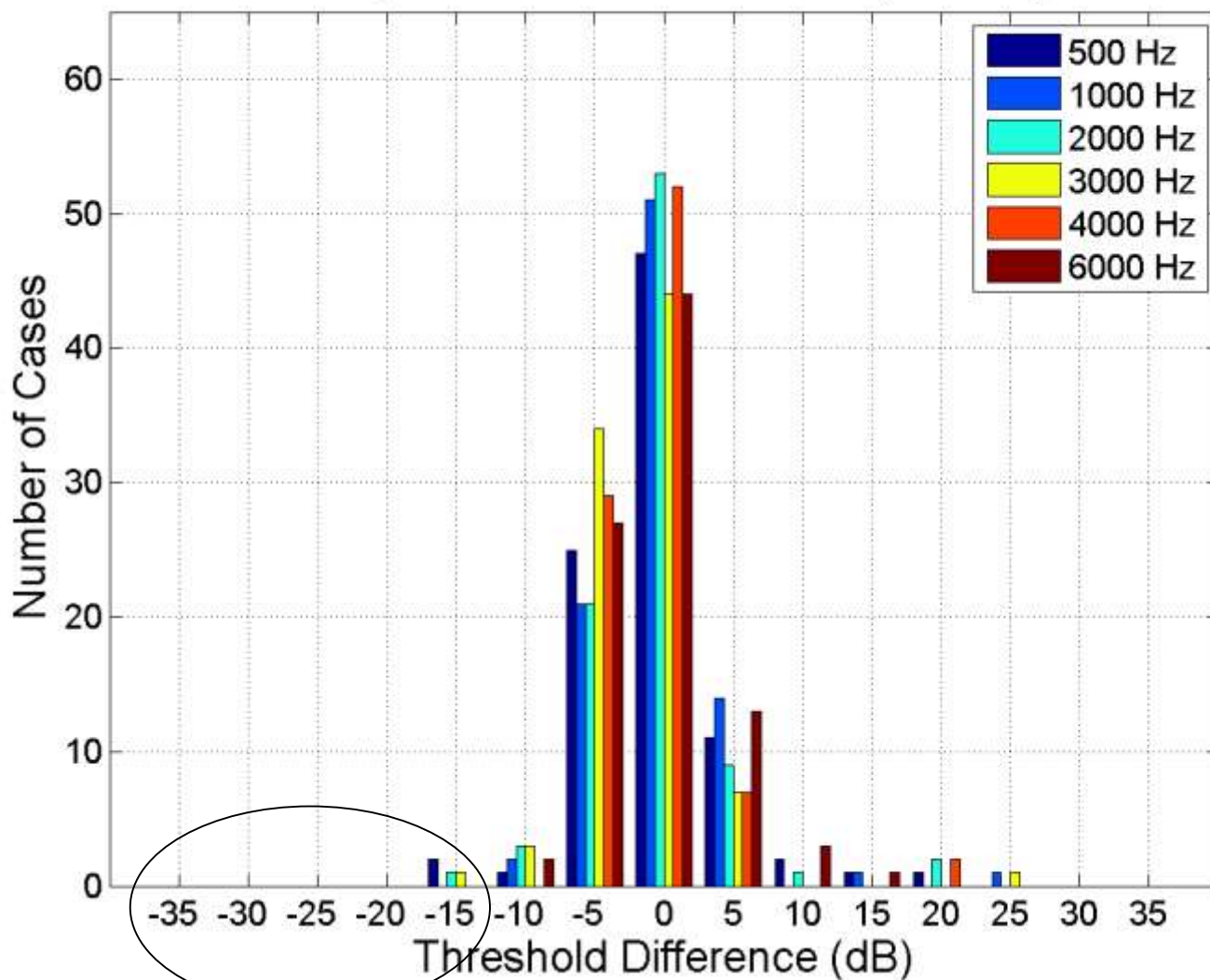
Camp Shelby Post Exposure Threshold Shifts ≥ 10 dB HL





WAHTS Post Exposure Threshold Shifts

Histogram of all threshold shifts (WAHTS)





APHC stands ready to Assist

Execution: Required unit level tasks PRIOR to training event include:

- ☐ **Contact the local Army Hearing Program Manager, local Audiologist, or the AHP (Army Public Health Center) at 410-436-3797 and coordinate:**
 - ☐ Request FitCheck System equipment (from local SME or APHC)
 - ☐ Unit medic training for both the FitCheck system and earpro fitting (by local SME)
 - ☐ Targeted Earpro Hearing Safety & Education brief (by local SME to ALL fire teams)
 - ☐ Placing Fire Teams in a more frequent hearing testing surveillance schedule
 - (6 months after training event or ASAP if Soldier reports a change in hearing after firing)
- ☐ **Order all 3 foam earpro sizes**
 - ☐ Small NSN – H3101101 Medium NSN – 6515-00-137-6345 Large NSN – H3101103
- ☐ **Secure location for both the FitCheck medic training and Soldier FitCheck testing**
- ☐ **Include in the NET schedule:**
 - ☐ Medic training for FitCheck system and earpro fitting (approx 2 hrs by local SME)
 - ☐ Initial Soldier FitCheck testing (approx. 15-30 min per Soldier by unit medics)
 - ☐ Targeted Earpro Hearing Safety & Education Briefing during classroom NET
 - ☐ (@ 30 min by local SME)
 - ☐ COA for any Soldier reporting hearing loss after firing (local MTF)





Questions and Discussion





Special Acknowledgement and THANKS!

*LTC M. Robinette, LTC A. Merkley, Chuck Jokel, Dr. AJ Kluchinsky,
Dr. M. Somanchi, Ms C. Eanes Keene, Ms P. Seaborne,*

*Dr. Mohanani, SAAB Test Team (particularly Stefan), PM MAAWS Team,
ATC Test Team, David Segure, Abby Webster, Olivia Webster, Cindy
Smith, APHC HPO Team (the Dawns), MAJ Jennings, CPT Schad,
MAJ Alexander, MAJ Lindholm, MAJ Young, CPT Scharier, LTC Curry-
Mathis, Melissa Webster, CPT Sletten, MAJ Bailey, Creare, Michaels
Associates, IzaBelle Sweet, Rebecca Holtman, Seth Boone, Jill Didon,
Richard Pack, Scott Hildebrand, Hector Galloza*

25th ID, 4/25 INFth ID, 10th ID, 2-22 INF Leaders, Soldiers and Medics

*APHC-E, JBER, JRTC, Ft Drum, Ft Bragg, Ft Benning, Ft Wainwright
(Awesome Audiology Support Teams)*

